Update on DVCS

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EIC Task Force meeting

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MILOU

Written by E. Perez, L Schoeffel, L. Favart [arXiv:hep-ph/0411389v1]

The code MILOU contains two different models for DVCS simulation:

FFS

Based on: Frankfurt, Freund and Strikman (FFS)
[Phys. Rev. D 67, 036001 (1998). Err. Ibid. D 59 119901 (1999)]

$$\frac{d^3\sigma^{DVCS}}{dx dQ^2 dt} = \frac{\pi^2\alpha^3 s\left(1+(1-y)^2\right)}{2xR^2Q^6} e^{-b|t|} F_2^2(x,Q^2)\left(1+\rho^2\right)$$

- Old model: written before data came out!
- Used by H1 and ZEUS for their DVCS measurements
- The ALLM parametrization for F_2 is used

GPDs-based

Based on: A. Freund and M. McDermott
All ref. in: http://durpdg.dur.ac.uk/hepdata/dvcs.html

- GPDs, evolved at NLO by an indipendent code which provides tables of CFF
  - at LO, the CFFs are just a convolution of GPDs:

$$\mathcal{H}(\xi,Q^2,t) = \sum_{u,d,s}\int_{-1}^{1}\left[\frac{e_i^2}{1-x/\xi-i\varepsilon} \pm \{\xi \to -\xi\}\right] H_i\left(x,\xi,Q^2,t\right)dx$$

MILOU

- provide the real and imaginary parts of Compton form factors (CFFs), used to calculate cross sections for DVCS and DVCS-BH interference.

$$\frac{d\sigma}{dxdyd|t|d\phi d\varphi} = \frac{\alpha^3 x_B y}{16\pi^2 Q^2 \sqrt{1+\varepsilon^2}} \left| \frac{\mathcal{I}}{e^3} \right| \qquad \phi = \phi_N - \phi_l \quad \varphi = \Phi_T - \phi_N \qquad \varepsilon \equiv 2x \frac{m_N}{Q}$$

$$|\mathcal{I}_{\mathcal{BH}}|^2 = \frac{e^6}{x^2 y^2 (1+\varepsilon^2)^2 \Delta^2 \mathcal{P}_1(\phi) \mathcal{P}_2(\phi)} \left\{ c_0^{BH} + \sum_{n=1}^{2} c_n^{BH} \cos(n\phi) + s_1^{BH} \sin(\phi) \right\}$$

$$|\mathcal{I}_{\mathcal{DVCS}}|^2 = \frac{e^6}{y^2 Q^2} \left\{ c_0^{DVCS} + \sum_{n=1}^{2} \left[c_n^{DVCS} \cos(n\phi) + s_n^{DVCS} \sin(n\phi) \right] \right\}$$

$$|\mathcal{I}|^2 = \frac{\pm e^6}{x y^3 \Delta^2 \mathcal{P}_1(\phi) \mathcal{P}_2(\phi)} \left\{ c_0^{I} + \sum_{n=1}^{3} c_n^{I} \cos(n\phi) + s_1^{I} \sin(\phi) \right\}$$

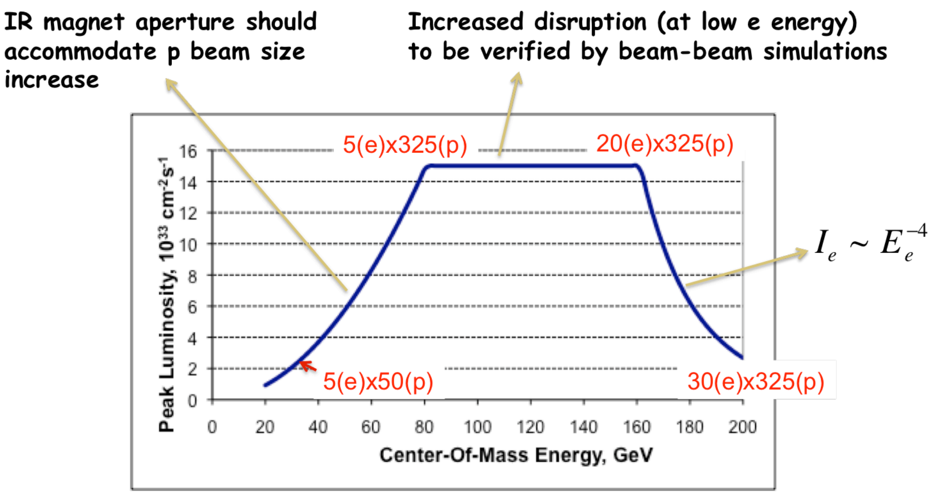
- The B slope is allowed to be costant or to vary with Q^2:

$$d\sigma / d|t| = \exp\left(B\left(Q^2\right)t\right); \quad with: \ B\left(Q^2\right) \approx \ln\left(Q^2\right)$$

- Proton dissociation ($ep \rightarrow e \gamma Y$) can be included

Phase space

- $1.5 < Q^2 < 100$ GeV^2
- $10^{-4} < x < 0.1$
- $0.01 < y < 0.85$
- $0 < |t| < 1.5$ GeV^2
- Radiative corrections: OFF
- t slope: B = 5.00 (costant)
- GPDs evolved at NLO
- ALLM param. used for F_2 (FFS model)



eRHIC Luminosity

30 X 325:

- E_el > 10 GeV

σ(ep -> eγp)= 0.186 nb (FFS_ALLM)

σ(ep -> eγp)= 0.376 nb (GPDs)

20 X 250:

- E_el > 5 GeV

σ(ep -> eγp)= 0.16 nb (FFS_ALLM)

σ(ep -> eγp)= 0.32 nb (GPDs)

10 X 100:

- E_el > 0 GeV

σ(ep -> eγp)= $8.1 \cdot 10^{-2}$ nb (FFS_ALLM)

σ(ep -> eγp)= 0.16 nb (GPDs)

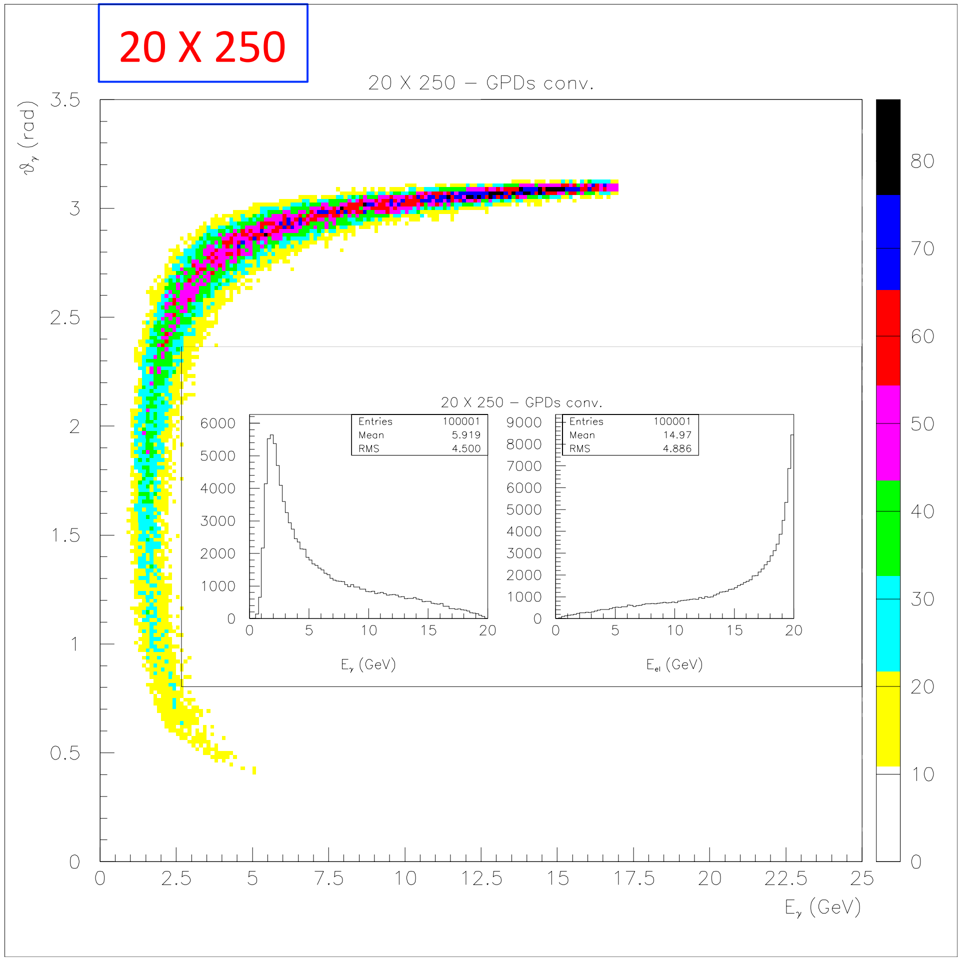
5 X 50:

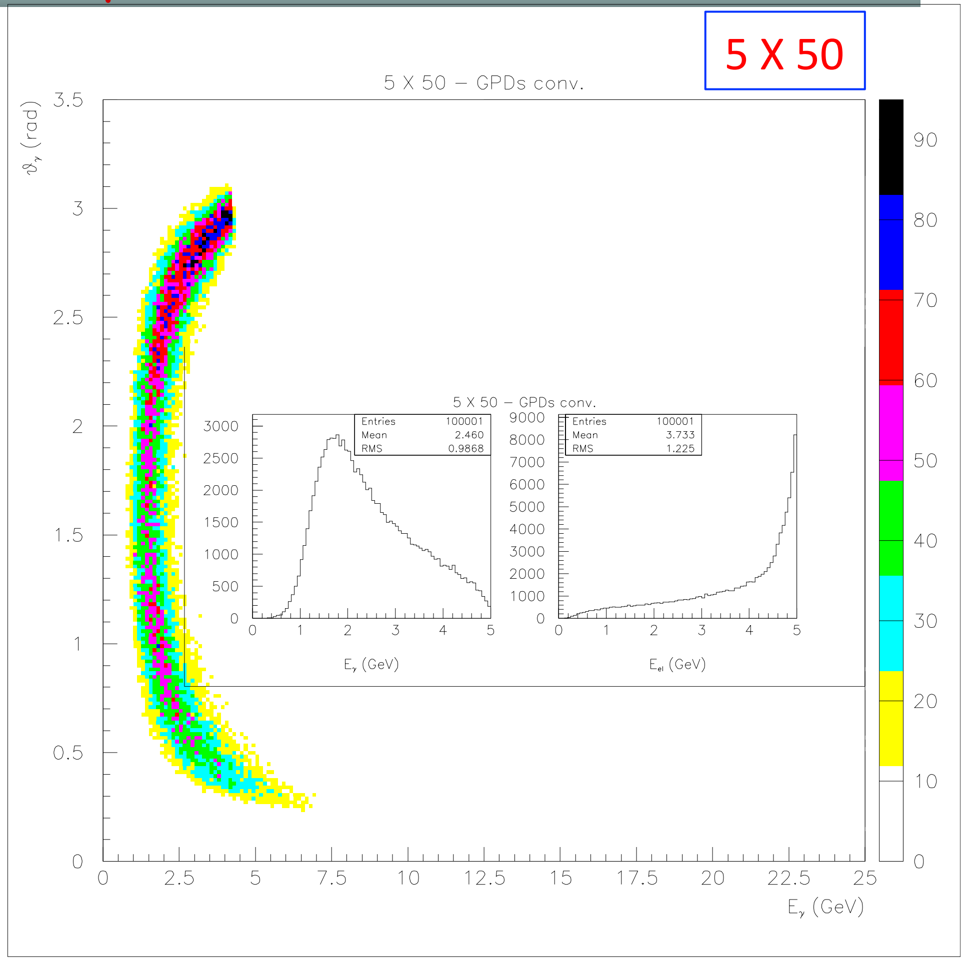
- E_el > 0 GeV

σ(ep -> eγp)= $8.1 \cdot 10^{-2}$ nb (FFS_ALLM)

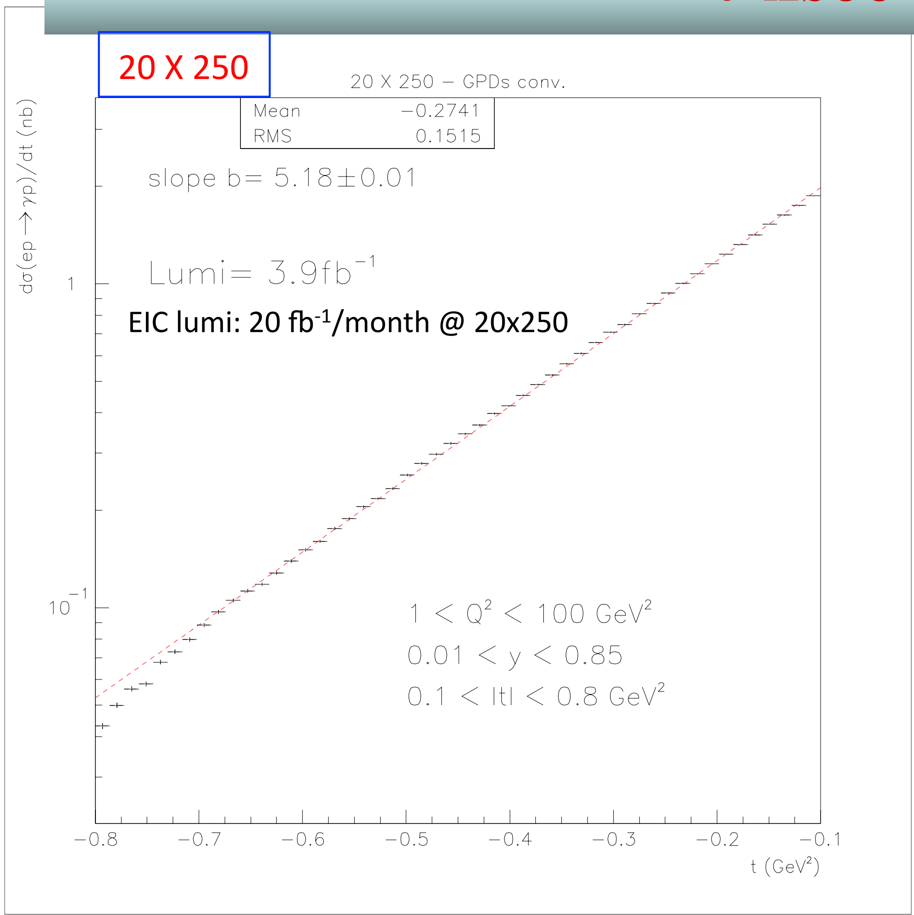
σ(ep -> eγp)= 0.16 nb (GPDs)

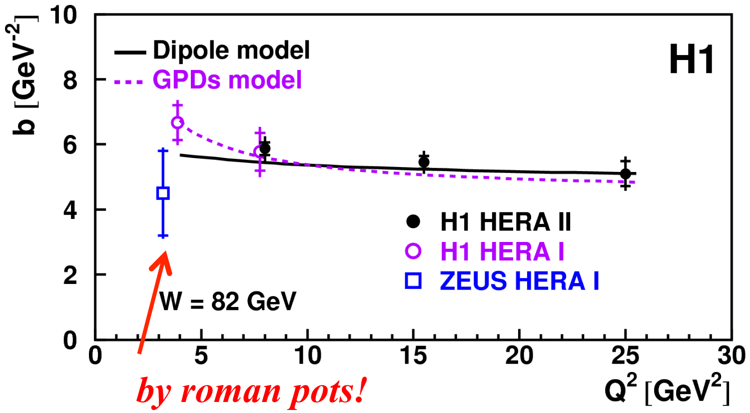
θ_γ vs E_γ

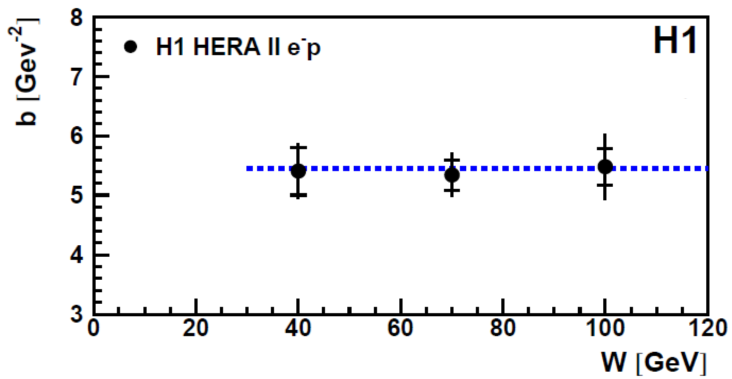




t-xsec (ep -> γp)







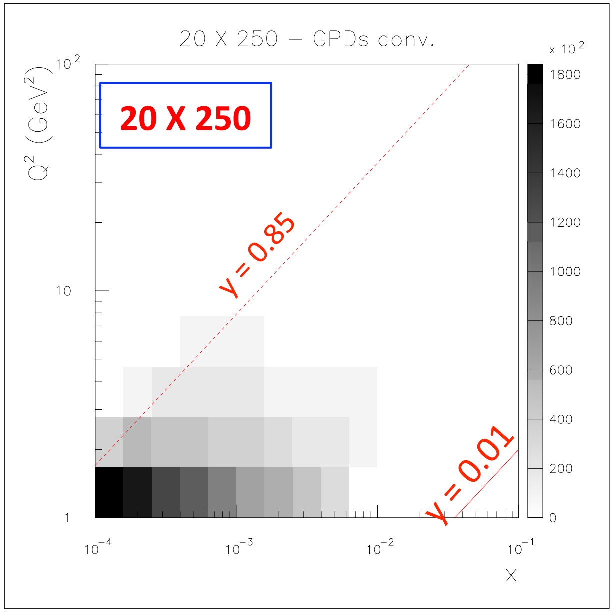
- ✧ EIC will provide sufficient luminosity to bin in multi-dimensions
- ✧ wide x and Q^2 range needed to extract GPDs

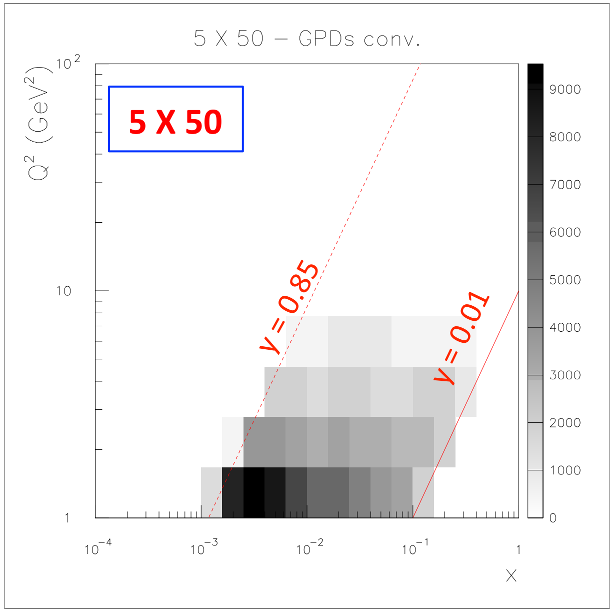
… *we can do a fine binning in Q2 and W!*

- Precision enormously improved
- Roman pots acceptance not yet included in the simulation

Systematics will dominate!!

Scanning the phase space…





Logarithmic bins:

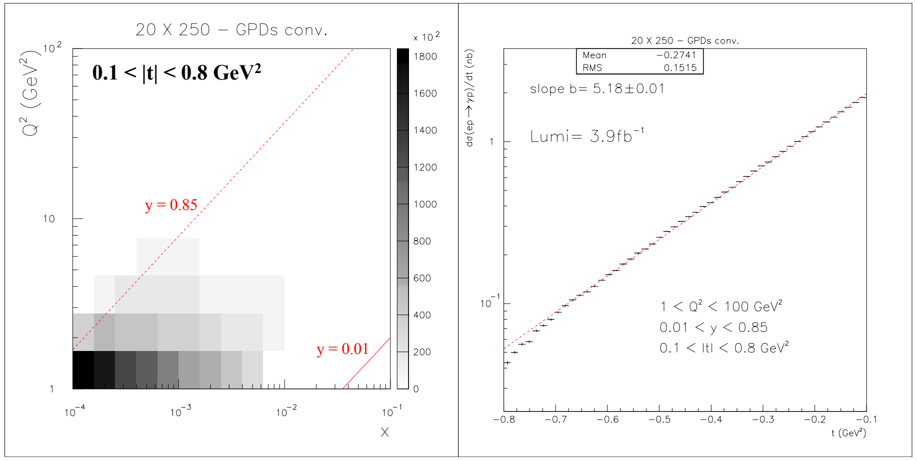
$1 < Q^2 < 100$ GeV^2

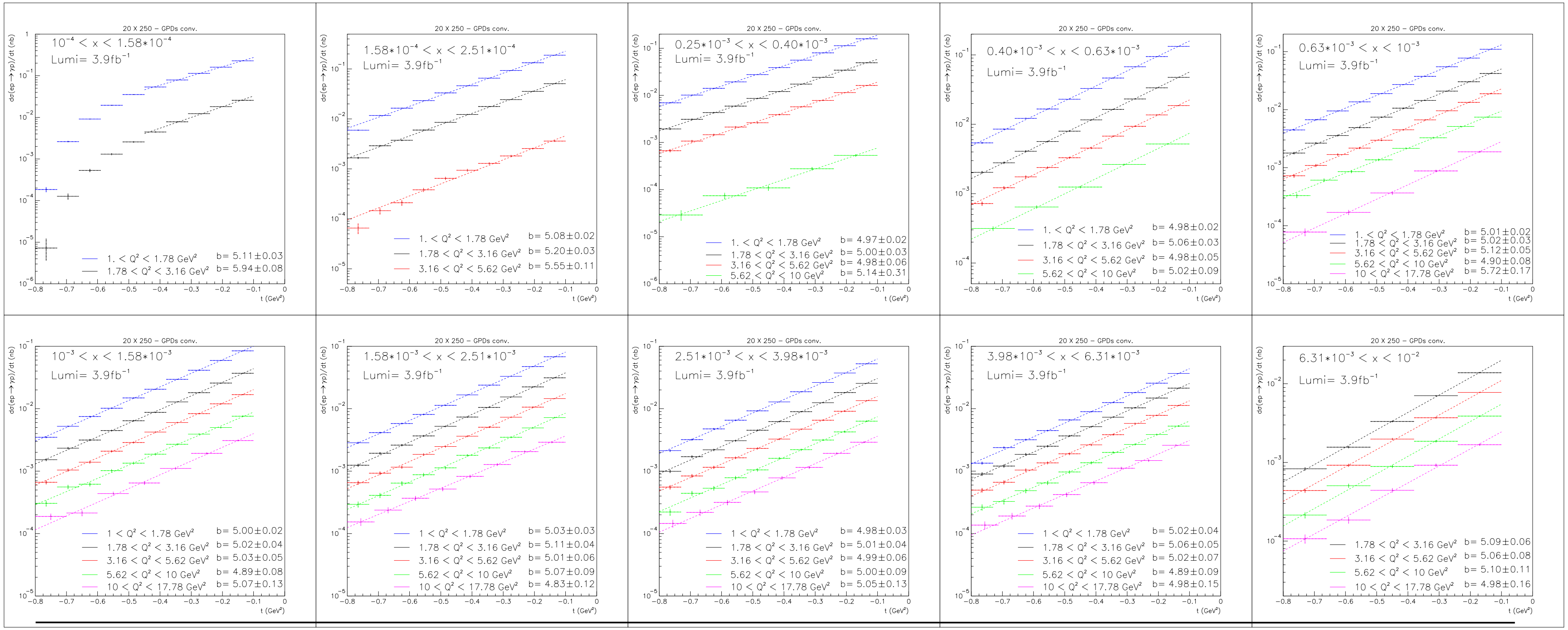
$10^{-4} < x < 0.1$

20 X 250

Lumi: 3.9 fb^{-1} (~ 1 week EIC)

$$\frac{d\sigma}{d|t|} = \frac{\#\,evt}{\Delta_{bin} \bullet \mathcal{L}}$$

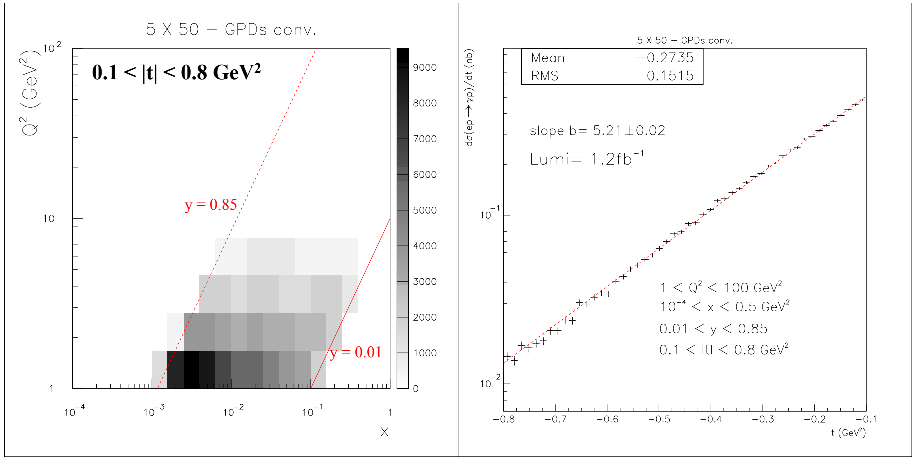


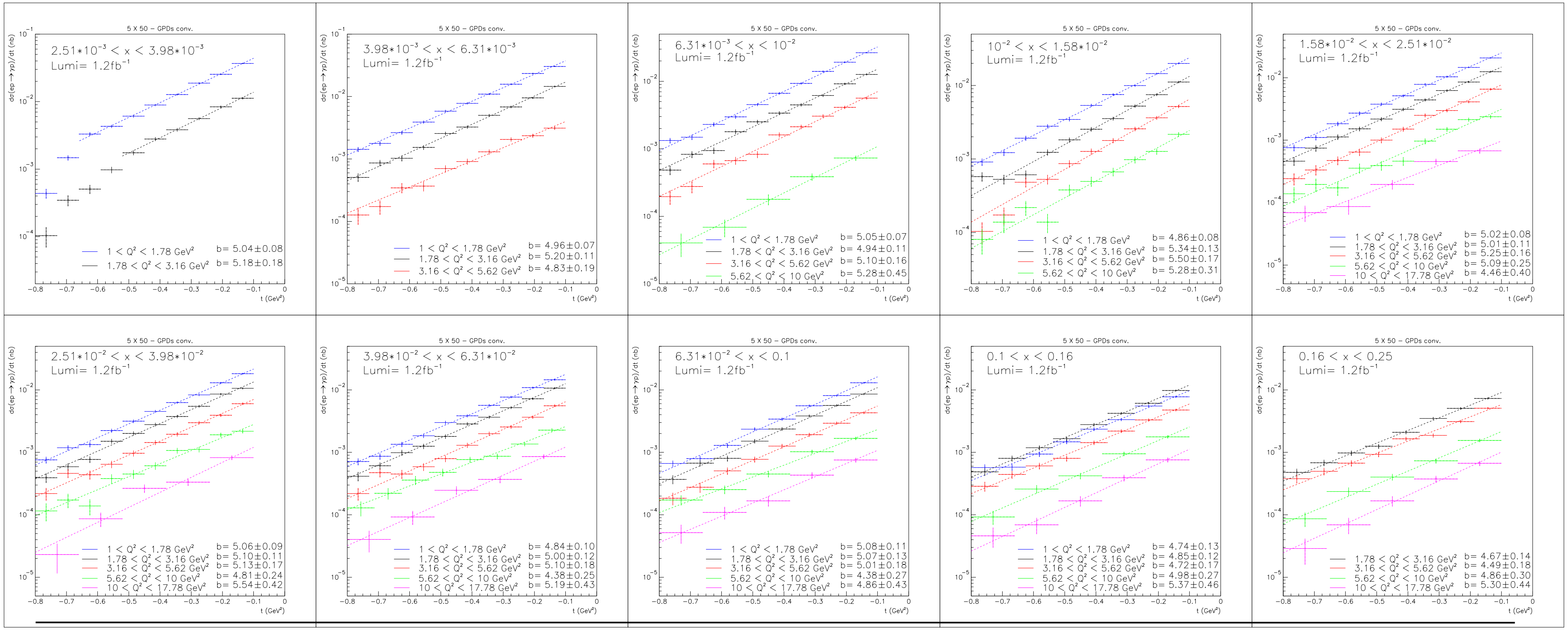


5 X 50

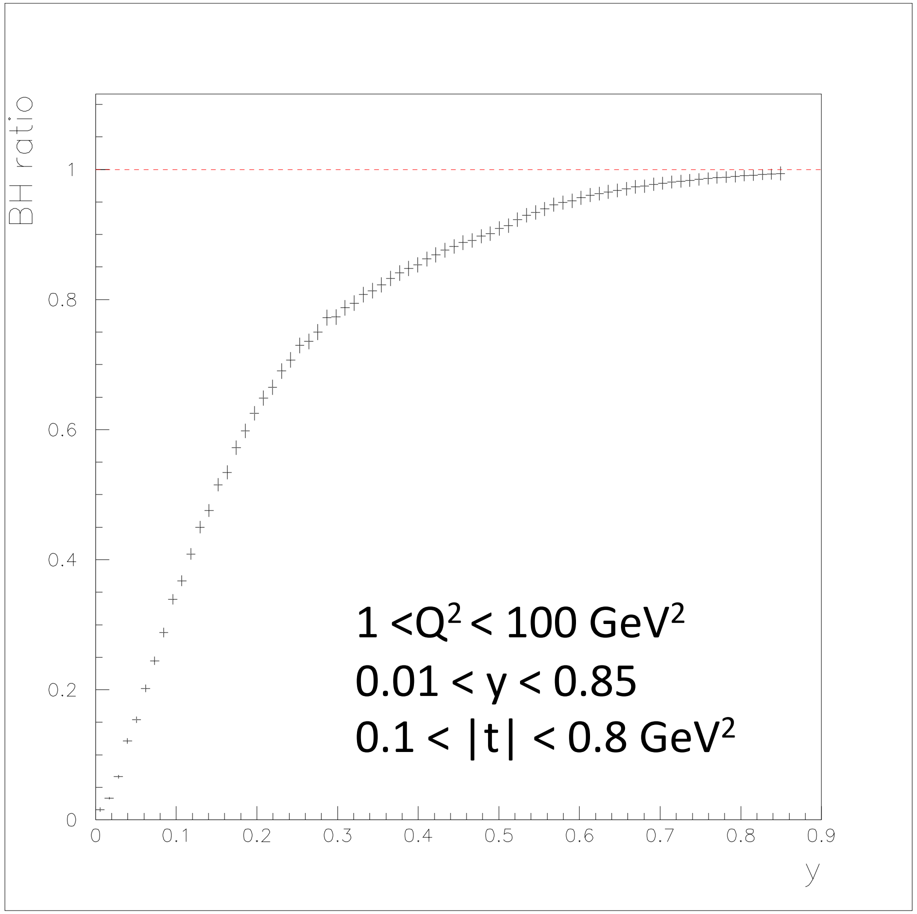
Lumi: 1.2 fb^{-1} (~ 1 week EIC)

$$\frac{d\sigma}{d|t|} = \frac{\#\,evt}{\Delta_{bin} \bullet \mathcal{L}}$$





Fraction of Bethe-Heitler



20 X 250: 1M of BH events generated

- E_el > 5 GeV
- $0 < |t| < 1.5$ GeV^2
- $10^{-4} < x < 0.5$

$\sigma(ep \to e\gamma p) = 0.2611$ nb

DVCS and BH samples normalized at Lumi

$$frac(BH) = \frac{BH_{evt}}{BH_{evt} + DVCS_{evt}}$$

- Proton dissociation not included for both DVCS and BH (but mostly process independent…)
- BH dominates at large y (as expected!)
- Part of BH will be removed by DVCS selection criteria (not affecting the interference term)

Summary

- Uncertainties will be dominated by systematics
- BH dominated at large y

Outlook:

- Simulation of asymmetries
- Use the CFFs from D. Mueller as an imput to MILOU
- Simulation of DVCS on nuclei